Marine Mammals of the Arabian Seas

Giuseppe Notarbartolo di Sciara, Robert Baldwin, Gillian Braulik, Tim Collins, and Ada Natoli

Abstract The marine mammal fauna found in the waters surrounding the Arabian Peninsula includes 24 species belonging to two Orders: Cetartiodactyla (Bryde's whale, blue whale, Omura's whale, humpback whale, sperm whale, dwarf and possibly pygmy sperm whale, Cuvier's beaked whale, Indo-Pacific common dolphin, pygmy killer whale, short-finned pilot whale, Risso's dolphin, killer whale, melon-headed whale, false killer whale, Indian Ocean humpback dolphin, pantropical spotted dolphin, striped dolphin, spinner dolphin, rough-toothed dolphin, Indo-Pacific bottlenose dolphin, common bottlenose dolphin, Indo-Pacific finless porpoise), and Sirenia (dugong). The knowledge of the conservation status of marine mammal populations in the Arabian seas region is still poor, due to the low density of local research and monitoring efforts, making it very difficult to compare the current condition of the region's marine mammals with that of conspecifics from other parts of the world. Anthropogenic pressure factors impacting on Arabian seas marine mammals include noise produced by seismic exploration, disturbance from poorly regulated or unregulated whale or dolphin watching operations, disturbance from vessel traffic and connected noise, ship strikes, direct takes, bycatch in fishery operations, pollution, habitat degradation caused by coastal development, extensive overfishing and harmful algal blooms. The dearth of information about the ecology of marine mammals from the Arabian region results in our enduring inability to understand where conservation action is most urgent.

G. Notarbartolo di Sciara (✉)
Tethys Research Institute, Milan, Italy

R. Baldwin
Five Oceans Environmental Services, Muscat, Sultanate of Oman

G. Braulik
University of St. Andrews, Fife, UK

T. Collins
Ocean Giants Program, Wildlife Conservation Society, NY, New York, USA

A. Natoli
UAE Dolphin Project, Dubai, United Arab Emirates

Zayed University, Dubai, United Arab Emirates

L. A. Jawad (ed.), *The Arabian Seas: Biodiversity, Environmental Challenges and Conservation Measures*, https://doi.org/10.1007/978-3-030-51506-5_26

Keywords Cetaceans · Dugong · Marine mammals · Threats · Conservation

1 Introduction

The marine mammal fauna found in the waters surrounding the Arabian Peninsula is among the world's least known, with uncertainties even regarding the species composition in the region. Records were found for 24 species belonging to two Orders: Cetartiodactyla (23 species of whales, dolphins and porpoises) and Sirenia (1 species, the dugong). Thirteen of these are regularly observed in the region or in parts of it, whilst 10 are rarely recorded (Table 1). Other cetacean species that occur in the wider tropical Indian Ocean, and might occur in the Arabian seas region because they have been recorded in nearby waters, are not included here because no confirmed record was found from the region. These include the Fraser's dolphin (*Lagenodelphis hosei*) and several little-known beaked whale species such as Longman's beaked whale (*Indopacetus pacificus*), Blainville's beaked whale (*Mesoplodon densirostris*) and Deraniyagala's beaked whale (*Mesoplodon hotaula*). Both species of *Kogia* were included here tentatively, considering the difficulty of telling them apart at sea, although confirmed records from the region based on strandings only exist for *Kogia sima*. Also highly migratory rorqual whale species such as fin whales (*Balaenoptera physalus*) and common minke whales (*B. acutorostrata*), not uncommon in the Indian Ocean at higher latitudes, might occasionally venture in the region; however no record was found of their presence.

The extreme variety of habitats offered by the Arabian seas region, including enclosed basins, each with an independent geological history, contrasted by long tracts of coastline exposed to wide oceanic water masses, is conducive to a complexity of biogeographic conditions creating niches for a diverse marine mammal fauna (see Table 1, 'Habitat type'). Relatively stable, high-level salinity and temperature environments, such as those found in the semienclosed basins of the Red Sea and the Arabian/Persian Gulf (thereafter referred as 'Gulf'), stand in stark contrast with those including the oceanic waters adjacent to the south coast of the Arabian Peninsula, whose climate and productivity are conditioned by a monsoon regime and vigorous upwelling phenomena creating changing conditions on a seasonal basis. Systems of submarine canyons off the Pakistani coast link coastal with deep marine ecosystems. This pattern is repeated on the coasts of southern Oman where the continental drop off approaches to within a few kilometres of the beach; deep diving cetacean species are occasionally seen with relative ease from the shore. Furthermore, the Arabian Sea is dominated by an ancient, persistent and deep oxygen minimum zone (OMZ) that extends across much of the northern half of the Arabian Sea basin (Reichart et al. 1998; Lachkar et al. 2018; More et al. 2018). Within the Arabian Sea OMZ waters between depths of 150–1000 m are highly anoxic (e.g. Banse et al. 2014) yet host a specialised and diverse ecosystem, including a huge abundance of mesopelagic fishes, particularly lanternfish (Myctophidae) and krill (Gilly et al. 2013). Lanternfish are typically small (<5 cm) and spend daylight hours in the anoxic waters of the OMZ but migrate

Table 1 Marine mammal species occurring in the Arabian Seas region inclusive of the following subregions as reported in the methods: Red Sea (RS); Gulf of Aden (GA); Arabian Sea (AS) (from the border with the Gulf of Aden to the border between Pakistan and India); Sea of Oman (SO); the Gulf (G). Red List (RL) status categories: EN (Endangered), VU (Vulnerable), LC (Least Concern), DD (Data Deficient). Preferred habitat is in bold

	Species	English name	Classification	Habitat	Presence in the different subregions	Current status (IUCN)	Research recommendations for improving status assessments
1	*Balaenoptera edeni*	Bryde's whale	Cetartiodactyla, Balaenopteridae	**Oceanic, coastal**	Regular throughout	LC	Clarify the ecology, taxonomy and abundance of regional populations as management concerns will be different (inshore vs. offshore)
2	*Balaenoptera musculus*	Blue whale	Cetartiodactyla, Balaenopteridae	**Oceanic**	Rare: GA, AS, SO, G	EN	Clarify the number of populations and broadly assess ecology
3	*Balaenoptera omurai*	Omura's whale	Cetartiodactyla, Balaenopteridae	**Slope, oceanic**	Rare: RS, G	DD	Revisit existing datasets to look for additional evidence of occurrence. Disseminate advice on distinguishing the species from other baleen whales
4	*Megaptera novaeangliae*	Humpback whale (Arabian Sea subpopulation)	Cetartiodactyla, Balaenopteridae	**Oceanic**	Regular: AS, SO Rare: RS, GA, G	EN[a]	Up-list to critically endangered. Establish a new regional work plan that is fully considerate of WWF key ecological attributes, the ASWN work plan and the CMS concerted action. Increase effort in understudied areas of the range
5	*Physeter macrocephalus*	Sperm whale	Cetartiodactyla, Physeteridae	**Slope**, oceanic	Regular: GA, AS, SO	VU	Improve data on regional species ecology. Assess linkages to other populations in the Indian Ocean. Assess interactions with fisheries, shipping and anthropogenic noise
6, 7	*Kogia sima* and *K. breviceps*	Dwarf and pygmy sperm whale	Cetartiodactyla, Kogiidae	**Slope**, oceanic	Rare throughout	LC	Disseminate advice on identifying species during surveys. Examine acoustic datasets for presence

(continued)

Table 1 (continued)

	Species	English name	Classification	Habitat	Presence in the different subregions	Current status (IUCN)	Research recommendations for improving status assessments
8	*Ziphius cavirostris*	Cuvier's beaked whale	Cetartiodactyla, Ziphiidae	**Slope**, oceanic	Rare: AS, SO	LC	Assess interactions with fisheries, shipping and anthropogenic noise
9	*Delphinus delphis tropicalis*	Indo-Pacific common dolphin	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Regular throughout, excluding northern Red Sea	DD	Improve current estimates of fisheries bycatch across the region, particularly in tuna and tuna-like fisheries. Work to improve mitigation
10	*Feresa attenuata*	Pygmy killer whale	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Rare: GA, AS, SO	LC	Disseminate advice on identifying species during surveys
11	*Globicephala macrorhynchus*	Short-finned pilot whale	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Rare: RS, AS, GA	LC	Disseminate advice on identifying species during surveys. Evaluate and address fisheries mortality in the region
12	*Grampus griseus*	Risso's dolphin	Cetartiodactyla, Delphinidae	**Slope**, oceanic	Regular: RS, GA, AS, SO	LC	Improve data on regional species ecology. Assess linkages to other populations in the Indian Ocean. Assess overlaps with fisheries, shipping and anthropogenic noise
13	*Orcinus orca*	Killer whale	Cetartiodactyla, Delphinidae	**Neritic, slope, oceanic**	Occasional AS, SO, G; rare: RS, GA	DD	Improve data on regional species ecology and population identity. Encourage reporting and data sharing with the northern Indian Ocean killer Whale Alliance (NIOKWA) group
14	*Peponocephala electra*	Melon-headed whale	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Rare: GA, AS	LC	Assess interactions with fisheries, shipping and anthropogenic noise given evident vulnerabilities to both. Improve understanding of strandings in the region, particularly in Socotra

15	*Pseudorca crassidens*	False killer whale	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Regular: RS, GA, AS, SO Rare: G	NT	Work to improve data on regional ecology, including interactions with fisheries. Develop a regional catalogue that mirrors that of the NIOKWA
16	*Sousa plumbea*	Indian Ocean humpback dolphin	Cetartiodactyla, Delphinidae	**Neritic**	Regular throughout	EN	Instigate and support efforts to improve data availability on distribution, abundance and population structure. Work to increase consideration of this species during coastal infrastructure projects (EIAs) and fishery activities
17	*Stenella attenuata*	Pantropical spotted dolphin	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Regular: RS, GA Rare: AS, SO, G	LC	Improve current estimates of fisheries bycatch across the region, particularly in tuna and tuna-like fisheries. Work to improve bycatch mitigation
18	*Stenella coeruleoalba*	Striped dolphin	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Rare: RS, GA, SO, AS	LC	Improve current estimates of fisheries bycatch across the region, particularly in tuna and tuna-like fisheries. Work to improve bycatch mitigation
19	*Stenella longirostris*	Spinner dolphin	Cetartiodactyla, Delphinidae	**Neritic, slope, oceanic**	Regular throughout	LC	Improve current estimates of fisheries bycatch across the region, particularly in tuna and tuna-like fisheries. Work to improve bycatch mitigation
20	*Steno bredanensis*	Rough-toothed dolphin	Cetartiodactyla, Delphinidae	**Slope, oceanic**	Rare: RS, GA, AS, SO	LC	Disseminate advice on identifying species during surveys
21	*Tursiops aduncus*	Indo-Pacific bottlenose dolphin	Cetartiodactyla, Delphinidae	**Neritic**	Regular throughout	NT	Strongly encourage further study of localised populations, including increased taxonomic assessment. Work to increase consideration of

(continued)

Table 1 (continued)

	Species	English name	Classification	Habitat	Presence in the different subregions	Current status (IUCN)	Research recommendations for improving status assessments
							this species during coastal infrastructure projects (EIAs)
22	*Tursiops truncatus*	Common bottlenose dolphin	Cetartiodactyla, Delphinidae	**Slope,** neritic	Regular: RS, AS, SO	LC	Improve current estimates of fisheries bycatch across the region, particularly in tuna and tuna-like fisheries. Work to improve bycatch mitigation
23	*Neophocaena phocaenoides*	Indo-Pacific finless porpoise	Cetartiodactyla, Phocoenidae	**Neritic**	Regular: G, SO (limited to the northern area, excluding Omani waters)	VU	Instigate and support efforts to improve data availability on distribution and abundance. Work to increase consideration of this species during coastal infrastructure projects (EIAs) and fishery activities
24	*Dugong dugon*	Dugong	Sirenia, Dugongidae	**Neritic**	Regular: RS, G	VU	Reference the CMS Dugong action plan

[a]EN status limited to the Arabian Sea subpopulation

vertically into oxygenated surface waters at night (Catul et al. 2011; Kinzer et al. 1993). At depth they form a major component of the deep scattering layer. The diel pattern of organisms within the deep scattering layer is likely to have a significant bearing in turn on the diel cycles of their predators (at several trophic levels), and several species of cetaceans are known to feed on deep scattering layer organisms at night when they are closer to the surface (Mateu et al. 2015). Within the Arabian Seas region, lanternfish and krill are described foods for Bryde's, blue and humpback whales (Mikhalev 1997, 2000), but dietary data are missing for most other regional species. However, it seems very probable that lanternfish at least are a significant prey item for several species (e.g. *Feresa attenuata*, *Stenella attenuata* and *S. coeruleoalba*), based on work completed elsewhere (e.g. Mateu et al. 2015; Sekiguchi et al. 1992; Wang et al. 2012). The Arabian Sea standing stock of lanternfish is likely very large (Gjosaeter 1984; Vipin et al. 2012) and a target of huge potential for the commercial fishmeal trade (Valinassab et al. 2007). The consequences of such a fishery on regional populations of predatory fish, squid and cetaceans are unknown. Presumably some regional species are significantly dependent on deep scattering layer prey items and have adapted to exploit them. However the link between regional cetaceans and the Arabian Sea OMZ deep scattering layer has never been studied.

This chapter summarises all the information available to date concerning marine mammal species confirmed to inhabit the region, provides recommendations to improve the current knowledge and identifies threats likely to impact the region's marine mammal population.

2 Methods

The region considered in this chapter comprises the marine water bodies surrounding the Arabian Peninsula and under the jurisdiction of the countries of Bahrain, Egypt, Eritrea, Djibouti, Iran, Iraq, Israel, Jordan, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, United Arab Emirates and Yemen. For the purposes of this book chapter, these waters are subdivided into five subregions: (1) the Red Sea; (2) the Gulf of Aden, separated from the Red Sea by the Strait of Bab el Mandeb and from the Arabian Sea by a line running south perpendicularly from the Yemeni coast to Cape Guardafui (a.k.a. Ràs Asir) in Somalia; (3) the Arabian Sea, from the boundary with the Gulf of Aden southwest to the boundary between Pakistani and Indian waters north east; (4) the Sea of Oman, delimited to the north by the Strait of Hormuz, and to the east by a line joining Ràs al Hadd, the easternmost point of the Arabian peninsula, and Ràs Jiyùni on the coast of Pakistan; and (5) the Arabian/Persian Gulf, hereafter referred to as the 'Gulf', west and north of the Strait of Hormuz (Fig. 1).

Species taxonomy and nomenclature used in this chapter follow the list of marine mammal species and subspecies published online by the Society for Marine Mammalogy's Committee on Taxonomy (2018), the taxonomic authority for marine mammals. Published and unpublished records from the region until 2018 were

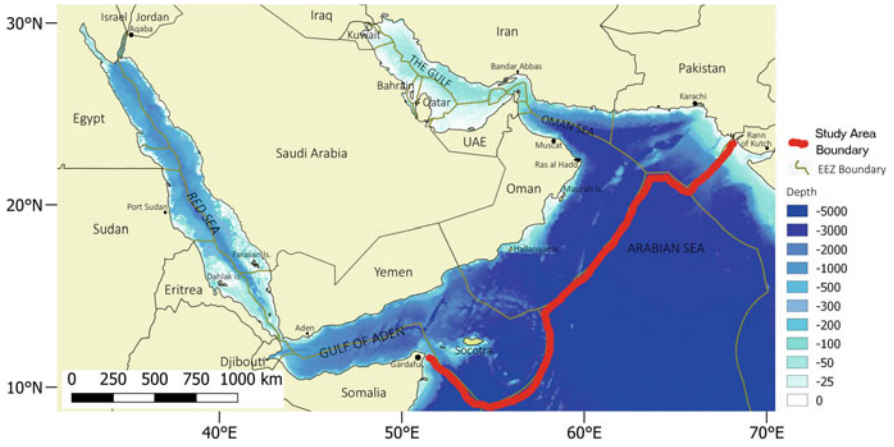

Fig. 1 The area considered in this review, including the waters under jurisdiction of Bahrain, Egypt, Eritrea, Djibouti, Iran, Iraq, Israel, Jordan, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, United Arab Emirates and Yemen

considered as sources of information in this review. The authors of species descriptions are not listed in the References List.

In the following section, for each species found in the Arabian region, a summary is provided of taxonomy, distribution and relative abundance, ecology, conservation and management considerations. The conservation status as evaluated on the IUCN Red List in its most recent assessment is given for each species.

3 Species

3.1 Cetartiodactyla, Cetacea

3.1.1 Mysticeti, *Balaenopteridae*

1. **Bryde's Whale,** *Balaenoptera edeni* (Anderson, 1879)

The Bryde's whale, *Balaenoptera edeni*, represents a species complex, the phylogeny for which is unresolved (Perrin and Brownell 2007). Two species are currently recognised, namely, *B. brydei* and *B. edeni (Committee on Taxonomy* 2018*;* Wada et al. 2003; Sasaki et al. 2006; Kanda et al. 2007; Kato and Perrin 2009). Based on genetic analysis, two subspecies of *B. edeni* are provisionally recognized: a larger pelagic form, *Balaenoptera edeni brydei*, with a circumglobal distribution in tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans and a smaller nearshore form, *B. e. edeni*, in the Indo-Pacific region (Committee on Taxonomy 2018). In the Arabian Seas, evidence from phylogenetic analyses, and corroborating morphological and behavioural studies, supports the presence of two taxonomic

units of *B. edeni*, including a potentially discrete population of the more offshore *B. e. brydei*, and an apparently more commonly occurring and widely distributed population of *B. e. edeni* in coastal areas which exhibits unusually low levels of genetic diversity (Kershaw et al. 2013).

Historical Soviet whaling records indicate large aggregations of both large- and small-form Bryde's whales in the Gulf of Aden (Mikhalev 2000), suggesting that this may be an important part of the ranges of both taxa. Bryde's whales are also recorded throughout the rest of the Arabian region (Baldwin 2003). Bryde's whales occur regularly in the Gulf and the Red Sea (Braulik et al. 2010a; Notarbartolo di Sciara et al. 2017). Off Oman, they are most frequently sighted off Muscat in the Sea of Oman as well as the coasts of Dhofar and the Gulf of Masirah in the Arabian Sea, though this is likely a reflection of relatively high observer effort in these areas. They are mostly recorded as singletons or in pairs, including mother-calf pairs, although small groups are also encountered, especially in association with feeding and breeding behaviour. Recorded prey species comprised small shoaling fishes, including lanternfish, mackerel and sardines, although some larger fishes, euphausiid crustaceans (krill) and mantis shrimps also appear in their diet (Mikhalev 2000).

Historic whaling data suggests the possibility of two reproductive seasons in the Arabian Seas (Mikhalev 2000), which is relatively usual for Bryde's whales (Kershaw et al. 2013). A relatively high sighting frequency as well as records of small calves (<6 m) point to the possibility that the Gulf of Masirah, may be an important breeding ground (Environment Society of Oman, unpublished data). Calves have also been recorded in the Gulf, Sea of Oman and Gulf of Aden (Baldwin 2003).

The IUCN Red List conservation status of Bryde's whales (*Balaenoptera edeni*) at the global level, all forms lumped together, is least concern (Cooke and Brownell 2018). In the Arabian Sea and Sea of Oman, illegal Soviet whaling in the mid-1960s resulted in the recorded mortality of 849 individuals (Mikhalev 2000). There is little current information on the status of the Bryde's whales in the region and on whether both forms share the same status, although evidence from relatively frequent strandings throughout much of its NWIO range suggests they are vulnerable to entanglement in gillnets and ship strikes (Kershaw et al. 2013). *Balaenoptera edeni* is included in Appendix I of Convention on the International Trade in Endangered Species (CITES) and Appendix II of the Convention on Migratory Species (CMS).

2. **Blue Whale,** *Balaenoptera musculus* (Linnaeus, 1758)

The taxonomy of the blue whale is not yet fully resolved but includes at least five subspecies. Blue whales in the Northern Indian Ocean are believed to be pygmy blue whales (*Balaenoptera musculus brevicauda* Ichihara, 1966) but may also include a distinct population of *Balaenoptera m. indica* (Blyth 1859). It is evident that at least some northern Indian Ocean blue whales comprise a resident population that does not migrate to Antarctica in the Austral summer; however it is possible that there are some shifts in distribution between areas in the region (Yochem and Leatherwood 1985; Mikhalev 2000; Anderson 2005; Branch et al. 2007).

The region's earliest record of blue whale presence is of one taken by whalers off the Al Hallaniyat Islands, Oman, in the Arabian Sea in December 1868 (Wray and Martin 1983). Records suggest that blue whales are rare but widespread in the region, occurring in the Gulf of Aden, Arabian Sea, Sea of Oman and the Gulf (Baldwin 2003). Recent detections of blue whale song recorded off the coast of Oman during the boreal winter (November through June) are congruent with the timing of Soviet catches in the region (Mikhalev 2000) and may indicate that blue whales are more common than sighting records suggest (Cerchio et al. 2018). Most records are from the Arabian Sea and Gulf of Aden where animals are presumably sustained by food sources associated with high productivity linked to seasonal upwelling (Baldwin 2003). In the region, their prey is known to include euphausiid crustaceans and sergestid shrimps (Mikhalev 2000; de Vos et al. 2018). Blue whales of the Arabian region are recorded in coastal areas but are mostly distributed in deep waters beyond the continental shelf (Branch et al. 2007).

The IUCN Red List Status of blue whales was assessed as endangered for all known forms at the global level (Cooke 2018). Pygmy blue whales are listed as data deficient (Cetacean Specialist Group 1996). There is no information on their current status in the region, though infrequent live sightings and strandings confirm their continued occurrence. They were subject to illegal Soviet whaling in the mid-1960s resulting in the mortality of 1294 blue whales (Mikhalev 2000). *Balaenoptera musculus* is included in Appendix I of CITES and Appendix I of CMS.

3. **Omura's Whale,** *Balaenoptera omurai* (*Wada*, Oishi and Yamada, 2003)

Balaenoptera omurai is a recently described species that is morphologically similar to the Bryde's whale but which represents a separate and ancient lineage within the balaenopterid clade (Sasaki et al. 2006). Cerchio et al. (2015) provide the first ecological description of the species based on research conducted in the northwest of Madagascar. Many details of the species' distribution and ecology are still unknown, but Omura's whale may have a wide tropical distribution globally.

A lack of *B. omurai* in a sample of 56 genetically analysed whale tissue specimens from Oman, Maldives and Bangladesh led Kershaw et al. (2013) to support earlier theories (Yamada et al. 2008; Yamada 2009) that the western limit of Omura's whale in the Eastern Indian Ocean is the Andaman Sea, off the western coast of the Malay Peninsula. However, a live stranding of a juvenile Omura's whale in the Gulf at Qeshm Island, Iran, in 2007 was recently positively identified (Ranjbar et al. 2016), a sighting off Egypt in the Red Sea in 2009, positively identified in 2017 (Notarbartolo di Sciara et al. 2017), and a confirmed sighting in Sri Lanka (de Vos 2017) provide strong evidence that this species occurs in the Arabian Seas region.

The IUCN Red List conservation status of Omura's whales at the global level is data deficient (Cooke and Brownell 2019). Information on the status of the species in the Arabian region is currently very limited, though the occurrence of a juvenile in Iran suggests that it may be a breeding resident. *B. omurai* is included in Appendix II of CITES and Appendix II of CMS.

4. **Humpback Whale,** *Megaptera novaeangliae* (Borowski, 1781)

Fig. 2 An Arabian Sea humpback whale, *Megaptera novaeangliae*, breaching near the Dhofar Coast, Southern Oman. The region is an Arabian Sea humpback whale hotspot and a focus of research activity over the past 20 years (credit: Darryl MacDonald/Environmental Society of Oman)

The humpback whale, originally described by Borowski in 1781, was recently divided into three subspecies based on genetic analysis (Jackson et al. 2014): *Megaptera novaeangliae kuzira* (Gray 1850) in the North Pacific, *M. n. novaeangliae* (Borowski 1781) in the North Atlantic and *M. n. australis* (Lesson 1828) (Clapham and Mead 1999) in the Southern Hemisphere. This study did not consider samples from the Arabian region where Gervais (1888) previously proposed recognition of *Megaptera indica* based on a specimen (skull and partial skeleton) of a humpback whale recovered from Basra Bay (Iraq) and now conserved at the Muséum National d'Histoire Naturelle in Paris (catalogued as MNHN-ZM-AC-1883-2255). Research off Oman, conducted since 1999, has revealed the presence of a geographically, demographically and genetically isolated population of humpback whales that inhabits the Arabian Sea year round (Fig. 2) (Baldwin et al. 1999; Mikhalev 2000; Minton et al. 2011; Pomilla et al. 2014). The data suggest that the Arabian humpback whales represent a distinct sub-species at least (Pomilla et al. 2014). Recent telemetry studies (Willson et al. 2016; Environment Society of Oman, unpublished data) have revealed high site fidelity to coastal sites off Oman, as well as a single deep-water excursion by a female that swam to the coastal waters off the west, southwest and southernmost tip of India. Their atypical nonmigratory behaviour is likely linked to the strong upwelling that characterises the Arabian Sea during the South West monsoon season. The upwelling allows them to feed locally and is a leading hypothesis for the founding of this highly discrete population (Papastavrou

and Van Waerebeek 1998). Based on genetic analyses completed to date, it has been estimated that the Arabian humpback whale population has been reproductively isolated from other populations for approximately 70,000 years (Pomilla et al. 2014). The geographical distribution of the population is poorly known but extends to the Iranian coast of the Sea of Oman in the north (Braulik et al. 2010a), into the Gulf in the west (Baldwin et al. 1999; Baldwin 2003; Dakhteh et al. 2017; Mikhalev 1997; Robineau 1998) the waters of Pakistan, Western India and possibly Sri Lanka in the east (Van Beneden 1887; Mikhalev 1997; Baldwin 2003; Gore et al. 2012), as well as the Gulf of Aden (Mikhalev 1997; Slijper et al. 1964). It is unknown whether humpback whales sighted in the northern Red Sea (Notarbartolo di Sciara et al. 2017) belong to the Arabian Sea population or whether they belong to a southern hemisphere population that spends the reproductive season in tropical and temperate waters of the Western Indian Ocean.

Arabian Sea humpback whales are mostly recorded as singletons or in pairs, although groups of up to 5 individuals have also been encountered, especially when engaged in breeding and feeding activity (Baldwin 2003; Minton et al. 2011; Environment Society of Oman, unpublished data). Prey is comprised almost exclusively of small shoaling fishes and euphausiid crustaceans (Mikhalev 2000).

Illegal Soviet whaling resulted in the capture of 242 humpback whales in Arabian seas in the mid-1960s. The population today remains small, with an estimated populations size of less than 100 individuals (Minton et al. 2008) based on mark recapture data from Oman. Threats to whales are widespread and include fishery entanglements (Minton et al. 2011; Anderson 2014; Moazzam and Nawaz 2014; Willson et al. 2016), ship strikes (Willson et al. 2016) and pollution (Baldwin et al. 2010; Dakhteh et al. 2017). These threats and the small size of this population led to its designation as endangered in the IUCN Red List (Minton et al. 2008), though some authors recommend that it satisfies the criteria for a listing as critically endangered (Pomilla et al. 2014). A recent worldwide review conducted by NOAA also concluded that Arabian Sea humpback whales are one of only four humpback whale populations still considered endangered under the US Endangered Species Act (NOAA 2016) (the others are all showing signs of recovery, whereas recent data collected from the Arabian Sea coast of Oman suggests that the population remains perilously small). *Megaptera novaeangliae* is included in Appendix I of CITES and Appendix I of CMS, and there is a CMS Concerted Action for the Arabian Sea humpback whale population.

3.1.2 Odontoceti, Physeteridae

5. **Sperm Whale,** *Physeter macrocephalus* (Linnaeus, 1758)

The sperm whale, *Physeter macrocephalus*, is distributed over a large geographic range (Rice 1998). It is found in nearly all marine regions, from the equator to high latitudes, generally in continental slope or deeper water habitats (Taylor et al. 2019). Regional subpopulations of sperm whales are known to exist (Taylor et al. 2019;

Engelhaupt et al. 2009), and Mikhalev (2000) suggests that sperm whales in the Arabian Sea form a discrete population. The absence of genetic study to date prevents any firm conclusions on this topic.

Catch data from whaling expeditions (Townsend 1931; Holt 1979; Wray and Martin 1983; Mikhalev 2000; Smith et al. 2013) and incidental sightings (e.g. Brown 1957; Slijper et al. 1964), as well as more recent sightings data from opportunistic platforms (e.g. Ballance and Pitman 1998) and dedicated surveys (e.g. Alling et al. 1982; Minton et al. 2010), suggest that sperm whales occur year round in the Arabian region. Mixed schools of nursing females and young individuals have been reported (Berzin 1971 in Gallagher 1991; Baldwin 1998), and Soviet catches of reproductively active males, lactating females and females in the early stages of pregnancy (Mikhalev 2000), show that sperm whales breed in the Arabian Sea. Furthermore, Mikhalev (2000) surmised from patterns in foetal length data that sperm whales have two distinct breeding cycles in the Arabian region, although this pattern could also be explained by the long gestation period of sperm whales (Mikhalev 2000). There is also some evidence of a clinal decline in average sperm whale lengths reported in WIO whaling statistics (Best et al. 2017).

Sperm whales are generally encountered in deep waters (128–3450 m) in the region (Gray et al. 2017) and are frequently associated with the continental shelf. The spatiotemporal pattern of sperm whale sightings generally reflects survey effort. Sightings are particularly abundant in the Arabian Sea off Dhofar in the south of Oman, which was an important whaling ground for whalers throughout the 1800s and 1960s (Wray and Martin 1983; Baldwin 2003; Smith et al. 2013). Some sightings were also reported in the Sea of Oman (Baldwin 1998; A. Natoli, pers. obs.). There are no confirmed records of sperm whales in the Gulf nor in the Red Sea (Notarbartolo di Sciara et al. 2017), despite the availability of deep water habitats in the latter.

Evidence for human-caused mortality, including those caused by ship-strike and fisheries interactions, have been described from an assessment of a limited number of strandings in Oman and the UAE (Gray et al. 2017). Other potential threats in the region include sound pollution from oil exploration activities (e.g. seismic and multi-beam echo sounder surveys) and military sonar (Baldwin 2003). At the global level, sperm whales are considered vulnerable according to the IUCN Red List (Taylor et al. 2019). *Physeter macrocephalus* is included in Appendix I of CITES and Appendix I and II of CMS.

3.1.3 Odontoceti, Kogiidae

6. Dwarf and 7. Pygmy Sperm Whales, *Kogia sima* (Owen 1866) and *Kogia breviceps* (de Blainville, 1838)

Dwarf and pygmy sperm whales have a similar overlapping worldwide distribution in tropical to warm-temperate waters, particularly over continental shelf and slope waters (Jefferson et al. 2015).

In the western Indian Ocean, dwarf sperm whales are uncommon but widely distributed; they occur from South Africa to the Gulf of Aden, the Sea of Oman and the Arabian Seas (Ballance and Pitman 1998; Baldwin et al. 1999; Jefferson et al. 2015). They are notoriously difficult to detect and frequently occur in a deep water, which may lead to reporting rarity. A pair of skulls were found entangled in a fishing net on a beach near to Sur, Oman in 2001 (ESO unpublished data); both are now in the collection of the Oman Natural History Museum. A stranded individual was reported from the southernmost reaches of the Red Sea in Eritrea (Notarbartolo di Sciara et al. 2017), another from the Gulf (A. Natoli, unpublished), a third from offshore of the Indus Delta in Pakistan (Gore et al. 2012) and another entangled in a gillnet in Pakistan (Nawaz and Moazzam 2014). A pygmy sperm whale was reported from Somniani, Pakistan, and is the only record of this species from the region (Gore et al. 2012). However, it is based on a third party report, and there are no substantiating photographs or other evidence to conclusively confirm its occurrence.

No information exists on the status of either of these species in the Arabian region. *K. sima* and *K. breviceps* are both listed as data deficient in IUCN's Red List (Kiszka and Braulik 2020a, b), and the species are listed in Appendix II of CITES.

3.1.4 Odontoceti, Ziphiidae

8. **Cuvier's Beaked Whale,** *Ziphius cavirostris* (G. Cuvier, 1823)

The Cuvier's beaked whale, *Ziphius cavirostris*, is a globally distributed species that inhabits continental slope and deep oceanic waters at all latitudes in both hemispheres. Despite their widespread distribution, this species is monophyletic, although some regional population structure is observed (Dalebout et al. 2005).

Cuvier's beaked whales are not commonly reported in the region. Their presence has been confirmed in the Arabian Sea, including at least six strandings from the southern beaches of the Al Hallaniyat Islands, and several live sightings (ESO, unpublished data) (Ballance and Pitman 1998, ESO unpublished data). Their Sea of Oman occurrence is based on a limited number of sightings and strandings in Oman (Alling 1986; Gallagher 1991; Baldwin et al. 1999) and Pakistan (Gore et al. 2008). There are no records from the Gulf, the Red Sea (Notarbartolo di Sciara et al. 2017) or the Gulf of Aden. However, the Gulf of Aden has oceanographic features that are similar to areas of known occurrence in the Arabian Sea and appears to be suitable beaked whale habitat. Data for this species in the region are otherwise very scarce and likely due to their preference for deep water and reclusive behaviour.

The conservation status of Cuvier's beaked whales at the world wide level is least concern according to the IUCN Red List (Taylor et al. 2008).

3.1.5 Odontoceti, Delphinidae

9. **Indo-Pacific Common Dolphin,** *Delphinus delphis tropicalis* (van Bree, 1971)

Currently, all common dolphins worldwide are classified as one species, *Delphinus delphis* (Committee on Taxonomy 2018), and the species distinction between *D. delphis* and *D. capensis*, once called, respectively, short-beaked and long-beaked common dolphin, has been removed. Four subspecies are recognised: *D. d. delphis*, *D. d. ponticus* from the Black Sea, *D. d. bairdii* inhabiting the coastal waters of the Eastern North Pacific, and *D. d. tropicalis* in the Indian Ocean, which retains the common name of 'long-beaked common dolphin' (Amaral et al. 2012; Cunha et al. 2015). Note that many common dolphin records from the Arabian region, dated before 2018, are listed as *Delphinus capensis*, based on the older nomenclature.

D. d. tropicalis is the only form known to occur in the Arabian, Gulf and Red seas, exhibiting an extremely long beak and high tooth counts when compared to common dolphin specimens from other regions (Jefferson and Van Waerebeek 2002). It is considered a regularly occurring species throughout the region. Long-beaked common dolphins have been recorded in the south of the Gulf, especially off the coast of Saudi Arabia; during surveys near Abu Ali Island in Saudi Arabia, common dolphins were the most frequently encountered species, accounting for 75% of all individuals sighted (Robineau 1998; Robineau and Fiquet 1996). It is one of the more frequently stranded species on both the Gulf and Sea of Oman coasts of Iran, and this maybe be linked to bycatch (Braulik et al. 2010a). It was the second most commonly encountered species during surveys in coastal waters of Oman in the early 2000s, occurring both in the Sea of Oman and in the Arabian Sea where they are especially abundant (Minton et al. 2010). It also occurs in the Red Sea, although it appears to be uncommon in the northern and central portions of that region (Notarbartolo di Sciara et al. 2017).

This species is frequently recorded as bycatch (Anderson 2014; Braulik et al. 2010a; Gore et al. 2017). There was a mass stranding of 11 Indo-Pacific common dolphins at Bandar-e-Jask on the Iranian coast, in 2011 (Mohsenian et al. 2014), and many strandings have been recorded in Oman (ESO unpublished data). The long-beaked common dolphin was one of the most frequently recorded dolphin species captured in gillnet operations targeting tuna in coastal and offshore waters of Pakistan (Nawaz and Moazzam 2014).

Delphinus spp. are included in Appendix II of CITES. Currently, *D. d. tropicalis* is considered to be data deficient, although it is still merged with other previously named long-beaked form populations. A new assessment will be revised soon (Fig. 3).

10. **Pygmy Killer Whale,** *Feresa attenuata* (Gray, 1874)

The pygmy killer whale, *Feresa attenuata*, is distributed in tropical and subtropical oceanic waters around the world, generally between 40°N and 35°S. It does not approach waters close to shore, except in some areas where deep, clear waters are very close to the coast (such as around oceanic archipelagos like Hawaii). A few high-latitude strandings and sightings are thought to be extralimital records (Braulik 2018).

Pygmy killer whales are uncommon in the Arabian region, as they are throughout the world. Knowledge of this species in the Arabian region is based on a few

Fig. 3 Indo-Pacific common dolphins, *Delphinus delphis tropicalis*, from the Dhofar Coast, Southern Oman, where they are frequently sighted near to shore (credit: Tim Collins/Environmental Society of Oman)

sightings in the Gulf of Aden, Arabian Sea and Sea of Oman in the early 1980s (Small and Small 1991; Baldwin et al. 1999), and its occurrence in the Red Sea (Notarbartolo di Sciara et al. 2017) or Gulf (Leatherwood et al. 1991) is considered doubtful. Since then it has not been documented at sea, but a desiccated carcass was discovered entangled in a gill net near Muscat, Oman, in April 2000 (Baldwin 2003).

The conservation status of pygmy killer whales at the global level is least concern (Braulik 2018). There is no information on the status of the species in the western and northern Indian Ocean. *Feresa attenuata* is included in Appendix II of CITES.

11. **Short-Finned Pilot Whale,** *Globicephala macrorhynchus* (Gray, 1846)

The genus *Globicephala* includes two widely recognised species, the long-finned pilot whale *Globicephala melas* (Traill 1809), found in the North Atlantic Ocean and across the Southern Hemisphere, and the short-finned pilot whale *G. macrorhynchus* (Gray 1846), distributed worldwide in tropical to warm-temperate waters.

Only *G. macrorhynchus* is known to occur in the tropical western Indian Ocean, including the Arabian Seas region (Jefferson et al. 2015), where it is considered rare (Baldwin 2003). Records of short-finned pilot whales from the area include sightings off the Horn of Africa and the eastern-most Gulf of Aden (Small and Small 1991; Eyre and Frizell 2012). They have also been observed, albeit rarely, in the Red Sea (Notarbartolo di Sciara et al. 2017) and in the Arabian Sea off Oman (ESO

unpublished data). No records of this species have been reported from the Gulf or the Sea of Oman.

The conservation status of short-finned pilot whales at the global level is considered to be least concern (Minton et al. 2018). Information on the status of the species in the western Indian Ocean is practically non-existent, although some bycatch in long-line fishery has been reported (Anderson 2014). *G. macrorhynchus* is included in Appendix II of CITES.

12. **Risso's Dolphin,** G*rampus griseus* (G. Cuvier, 1812)

The genus *Grampus* is monotypic and ranges worldwide in temperate and tropical waters, preferring deep, steeply sloping habitats over continental slopes and around oceanic islands (Jefferson et al. 2014).

Risso's dolphins range extensively across the tropical western Indian Ocean, including the Gulf of Aden (Alling 1986), the Sea of Oman (Baldwin 2003; Braulik et al. 2010a), the wider Arabian Sea (Eyre 1995; Baldwin 2003; Jefferson et al. 2014) and the Red Sea (Notarbartolo di Sciara et al. 2017). It is likely to be one of the commonest cetacean species in deep waters of the western tropical Indian Ocean (Gore et al. 2012; Ballance and Pitman 1998). In Pakistan, it has been recorded as occasional bycatch in tuna gillnet fisheries (Nawaz and Moazzam 2014). There are no confirmed records of this species from the Gulf, and Risso's dolphins being a deep water species this basin is not expected to be a suitable habitat for them.

The global status of *Grampus griseus* is listed as least concern on IUCN's Red List (Kiszka and Braulik 2018a). There is no information on the status of the species in the Arabian Seas. The species is included in Appendix II of CITES, and its North and Baltic seas populations are listed in Appendix II of the CMS.

13. **Killer Whale,** *Orcinus orca* (Linnaeus, 1758)

Killer whales are among the most widespread mammals on Earth, occurring in polar as well as tropical waters. One single species, *Orcinus orca*, is recognized worldwide although different eco/morpho types are described both in the northern and southern hemisphere (Morin et al. 2010).

The information on this species in the northern Indian Ocean is relatively scarce. A 'Northern Indian Ocean (NIO) killer whale ID catalogue' is maintained by the Northern Indian Ocean Killer Whale Alliance (NIOKWA) in an attempt to concentrate the effort and information on this species gathered by scientists in the region (http://niokillerwhales.wix.com/niokwa). Killer whales appear to occur with some regularity in the Gulf (Baldwin et al. 1999; A. Natoli, pers. obs.), Sea of Oman and Arabian Sea (Baldwin 2003; ESO unpublished data; Gore et al. 2012), and they are only rarely observed in the Red Sea (Notarbartolo di Sciara et al. 2017). Their occurrence in the Gulf of Aden was considered uncertain by Leatherwood et al. (1991), despite evidence to the contrary, including sightings in Djibouti and Somalia (e.g. Robineau and Rose 1984; Small and Small 1991). A NIO killer whale ecotype has not yet been defined, and whether or not this species is resident in the Arabian region or just an occasional visitor is unclear. However, one individual sighted in Abu Dhabi (UAE) in 2008 was resighted in Sri Lanka in 2015 (G.L. Gemmell, pers.

comm.), suggesting that killer whales in this region migrate long distances. Killer whales were sighted in the Sea of Oman and Arabian Sea in 2016 and 2017 (ESO unpublished data), at least twice in the Gulf in 2017, in both Iran and UAE waters and once in 2018 in Iran (H. Moshiri, pers. comm.) supporting its consistent presence in the area.

The conservation status of killer whales at a global level is 'data deficient' (Reeves et al. 2017). It is listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) and Appendix II of the Convention on Migratory Species (CMS).

14. **Melon-Headed Whale,** *Peponocephala electra* (Gray, 1846)

The melon-headed whale, *Peponocephala electra*, has a pantropical distribution (Perryman and Danil 2018). The distribution coincides almost exactly with that of the pygmy killer whale in tropical/subtropical oceanic waters between about 40°N and 35°S (Jefferson and Barros 1997).

The species is little known in the seas surrounding the Arabian Peninsula. A damaged skull collected from the Al Hallaniyat Islands, Oman, in 1982, is the first of just three confirmed records of this species in the region (Van Waerebeek et al. 1999). These records indicate a nominal distribution that includes the Arabian Sea and Gulf of Aden (Baldwin 2003). Three stranding events involving large numbers (35, 60 and 67 individuals, respectively) of melon-headed whales were reported from the Socotra Archipelago (Yemen) and the channel between Abd el Kri and Ras Gardafui in 2017; the available information is limited, but images suggest the strandings may be linked to fisheries interactions; there were clear indications of secondary use, including abundant incisions made by knives (pers. comm. to Tim Collins, Yemen Environment Protection Agency; also reported on 'Tayf, the Soqotra Newsletter', https://bit.ly/2Kwh65t).

The conservation status of melon-headed whales at the global level is least concern (Kiszka and Brownell 2019). There is no information on the status of the species in the western Indian Ocean. *Peponocephala electra* is included in Appendix II of CITES.

15. **False Killer Whale,** *Pseudorca crassidens* (Owen, 1846)

The genus *Pseudorca* is monotypic, with no subspecies recognised. False killer whales occur at tropical and warm-temperate latitudes in all oceans and many connected sea basins such as the Mediterranean and Caribbean seas and the Gulf of Mexico (Jefferson et al. 2015). They are mostly found in oceanic waters, although their presence in waters over the continental shelf, in coastal waters, around islands and even in bays, is not uncommon. Throughout their range, false killer whales regularly engage in depredation on both catch and bait in hook-and-line fisheries which has resulted in bycatch rates high enough to cause population declines in some areas (Oleson et al. 2010).

False killer whales are widely distributed throughout the Arabian region, including in the Red Sea (Notarbartolo di Sciara et al. 2017), the Gulf of Aden (Mörzer Bruyns 1969; Robineau and Rose 1984; Leatherwood et al. 1991), the Sea of Oman

(Mörzer Bruyns 1969; Weitkowitz 1992; Baldwin 2003; Braulik et al. 2010a), the Arabian Sea (Baldwin 2003; Nawaz and Moazzam 2014) and the Gulf (Mörzer Bruyns 1969; Al-Robbae 1971; Baldwin 2003). This species is known to be a breeding resident in the Sea of Oman at least and probably elsewhere in the Arabian seas (Baldwin 2003).

P. crassidens is listed as near threatened in IUCN's Red List (Baird 2018). There is no information on its status in the Arabian Seas. The species is listed in Appendix II of CITES.

16. **Indian Ocean Humpback Dolphin**, *Sousa plumbea* (G. Cuvier, 1829)

The genus *Sousa* comprises four recognized species: S. *teuszii*, S. *chinensis*, S. *sahulensis* and S. *plumbea* (Mendez et al. 2011, 2013). The first three occur, respectively, in the eastern Atlantic Ocean (western Africa), eastern Indian and western Pacific Ocean, including northern and eastern Australia. The latter is the only species inhabiting the tropical and subtropical western Indian Ocean including the eastern African coast, Madagascar and the Arabian region.

S. plumbea is an exclusively coastal species that is frequently reported from very shallow nearshore waters. This is one of the most commonly recorded species in the Arabian Seas. It shows a largely continuous distribution along much of the coastline from the Gulf to the northern Red Sea, with a few notable exceptions including the Sea of Oman coast from Dibba (UAE/Oman) to Ras Al Hadd (Oman) and the Gulf of Aqaba (Jefferson and Karczmarski 2001; Baldwin et al. 2004; Kiani and Van Waerebeek 2015; Notarbartolo di Sciara et al. 2017). Despite their extensive occurrence, individuals are generally resident in discrete coastal areas and rarely travel long distances, mostly showing a habitat range of a maximum of a few 100 km (Diaz Lopez et al. 2017). Recent work also demonstrates highly significant genetic structure between putative populations in the Western Indian Ocean, a pattern that appears to be linked to environmental factors (Mendez et al. 2011). Approximately 700 individuals are estimated to inhabit Abu Dhabi waters, one of the largest known populations of this species (Diaz Lopez et al. 2017). This is one of the most commonly sighted species in Iranian waters of the Gulf (Braulik et al. 2010a), and a population in Mousa Bay, near the border with Iraq, is estimated as 92 individuals (Hemami et al. 2018). Their preference for discrete home ranges predisposes them to population fragmentation which, together with their coastal habitat preference, make this species highly susceptible to anthropogenic impacts such as habitat loss/degradation, land reclamation, pollution, overfishing and bycatch (e.g. Mendez et al. 2011; Braulik et al. 2017). The species is the focus of dolphin watching industries in both the Musandam and Dhofar regions of Oman (see https://wwhandbook.iwc.int/en/).

A recent IUCN reassessment for the Red List classified this species as endangered (Braulik et al. 2017) based on high human-induced mortality and a decreasing population trend recorded across the majority of its range. The species is listed in Appendix II of CITES and in Appendix II of CMS.

17. **Pantropical Spotted Dolphin,** *Stenella attenuata* (Gray, 1846)

Pantropical spotted dolphins consist of two recognised subspecies: *S. a. attenuata* (Gray 1846), which occurs offshore and is pantropical, and *S. a. graffmani* (Lönnberg 1934), which is coastal and limited to the waters of the Pacific coast of Latin America from southern Mexico to Peru (Perrin 2001). Only the former occurs in the Arabian region.

S. attenuata is one of the most common cetaceans in the Red Sea (Notarbartolo di Sciara et al. 2017), and it is also frequently observed in the Gulf of Aden and more generally in offshore waters throughout the tropical Indian Ocean (Jefferson et al. 2015). It has only rarely been recorded during surveys in the Sea of Oman (Baldwin and Salm 1994; Baldwin et al. 1999) and Arabian Sea (Gore et al. 2017; Kiani et al. 2011; Baldwin 2003). Small and Small (1991) reported several sightings in the Gulf of Aden off northern Somalia, including schools of up to 2000 individuals. Its occurrence in the Gulf is considered rare (Baldwin et al. 1998, 1999). Pantropical spotted dolphins were reported to be frequently enmeshed in gillnets set to catch tuna in Pakistani waters (Nawaz and Moazzam 2014).

Pantropical spotted dolphins are listed as least concern in IUCN's Red List (Kiszka and Braulik 2018b). No information is available on their status in the Arabian seas. The species is listed in Appendix II of CITES. The eastern tropical Pacific population and the Southeast Asian populations are also listed in Appendix II of CMS.

18. **Striped Dolphin,** *Stenella coeruleoalba* (Meyen, 1833)

The striped dolphin, *Stenella coeruleoalba*, is found worldwide in offshore tropical and warm-temperate waters (Braulik 2019). Although there are some geographic differences between populations, no subspecies have been recognized to date (Rice 1998; Jefferson et al. 2015).

The striped dolphin is rarely reported in the Arabian region but may be more common than these records suggest. The first record was of a skull found along the shores of Oman (Sea of Oman) in 1977 (Gallagher 1991). It has since been sighted alive only a few times during survey work in the Sea of Oman (Fujairah, United Arab Emirates), Arabian Sea, Pakistani waters (Kiani et al. 2013), Gulf of Aden and Red Sea off Saudi Arabia (Baldwin 2003; Notarbartolo di Sciara et al. 2017). Strandings have been recorded in Oman (ESO unpublished data) and Iran, the latter including a live mass stranding of 73 individuals in 2007 (Braulik et al. 2010b). It is however one of the species most frequently enmeshed in gillnets set to catch tuna in Pakistan, and therefore it may be more common in seldom surveyed offshore waters (Nawaz and Moazzam 2014). It is apparently common further south in the northern and central Indian Ocean (Ballance and Pitman 1998).

The IUCN Red List conservation status of striped dolphins at the global level is least concern (Braulik 2019). There is no information on the status of the species in the western Indian Ocean. *Stenella coeruleoalba* is included in Appendix II of CITES. The eastern tropical Pacific and Mediterranean populations are also listed in Appendix II of CMS.

19. **Spinner Dolphin,** *Stenella longirostris* (Gray, 1828)

Spinner dolphins are a pantropical species, of which four subspecies are currently recognised: the nominate *S. l. longirostris* (Gray 1828) which is circumtropical, *S. l. orientalis* Perrin 1990 and *S. l. centroamericana* Perrin 1990 from the eastern tropical Pacific, and *S. l. roseiventris* (Wagner 1846), a small form of spinner dolphin from the coastal waters of Southeast Asia and northern Australia. Spinner dolphins in the northwestern Indian Ocean, including the Arabian region, are currently regarded as *S. l. longirostris*, although other forms may be revealed through further investigation (Notarbartolo di Sciara et al. 2017). For instance, apparently smaller spinner dolphins reported from inshore waters off Oman are yet to be further studied and may represent an undescribed form or subspecies (Baldwin and Salm 1994; Van Waerebeek et al. 1999; Minton et al. 2010). Spinner dolphins are one of the most commonly encountered cetacean species in Arabian Seas (Ballance and Pitman 1998; Gore et al. 2012). They occur in inshore and offshore waters of the Red Sea (Notarbartolo di Sciara et al. 2017), the Gulf of Aden and the Arabian Sea (Robineau and Rose 1983; Small and Small 1991; Baldwin et al. 1999; Minton et al. 2010; Gore et al. 2012), the Sea of Oman (Van Waerebeek et al. 1999; Baldwin 2003; Minton et al. 2010) and the Gulf (Mörzer Bruyns 1971). They appear to be most abundant in the Sea of Oman, Gulf of Aden, Red Sea and the waters off Pakistan and less common in the southern Arabian Sea and Gulf (Baldwin 2003). A mass stranding of 79 spinner dolphins on the Iranian coast of the Sea of Oman in 2007 was attributed to fisheries-related mortality (Braulik et al. 2010b). Spinner dolphins are the most frequently captured cetacean species in gillnets set by Pakistani fishers targeting tuna, which may reflect their local abundance (Nawaz and Moazzam 2014).

Spinner dolphins are assessed as least concern on IUCN's Red List (Braulik and Reeves 2018). No information is available on the species' status in the Arabian region. *S. longirostris* is listed in Appendix II of CITES. The eastern tropical Pacific population and the southeast Asian populations are also listed in Appendix II of CMS (Fig. 4).

20. **Rough-Toothed Dolphin,** *Steno bredanensis* (Lesson, 1828)

Steno is a monotypic genus, with no sub-species recognised. The complex history of the species' taxonomy was treated in detail by W. Schevill in Watkins et al. (1987) and summarised by Miyazaki and Perrin (1994). Rough-toothed dolphins are a cosmopolitan species confined to tropical and warm-temperate latitudes, mostly found in deep oceanic waters and over steep slopes (West et al. 2011).

In the northwestern Indian Ocean, rough-toothed dolphins have been observed in many locations throughout the Arabian region, including the Gulf of Aden off Somalia, the Sea of Oman (Ballance and Pitman 1998; Baldwin et al. 1998, 1999; Van Waerebeek et al. 1999; Johnson 2004; Minton et al. 2010) and waters off Pakistan (Kiani et al. 2013). Their presence in the southern Red Sea is documented by two strandings in Eritrea (Notarbartolo di Sciara et al. 2017), and there was a live stranding in 2011 near Bandar Abbas in Iranian waters of the Gulf (Mohsenian et al. 2013). Several rough-toothed dolphins were among a larger group of bottlenose dolphins that stranded alive near Ras al Hadd in Oman during April 2002. All stranded individuals died, and local fishermen attributed the event to the presence

Fig. 4 A pod of spinner dolphins, *Stenella longirostris*, resting in the sheltered waters of an offshore reef in the Red Sea (credit: Maddalena Fumagalli/HEPCA)

of killer whales offshore the day before (Collins et al. 2002). The shallow waters of the Gulf suggest that that their occurrence is unlikely.

Rough-toothed dolphins are listed as least concern in IUCN's Red List (Kiszka et al. 2019). No specific information is available on their status in the Arabian seas. The species is listed in Appendix II of CITES.

21. **Indo-Pacific Bottlenose Dolphin**, *Tursiops aduncus* (Ehrenberg, 1833)

The genus *Tursiops* is still subject to extensive taxonomic debate. *Tursiops* occurs worldwide and inhabits both oceanic and coastal waters. They exhibit wide morphological variability, and over 20 different species have been described (Hershkovitz 1966). Currently, only two species are officially recognized, the Indo-Pacific bottlenose dolphin, *T. aduncus* (Ehrenberg 1833) and the common bottlenose dolphin, *T. truncatus* (Montagu 1821). However, for both species, recent morphological and genetic studies suggest the presence of many different lineages and the possible existence of different taxa (Hoelzel et al. 1998; Wickert et al. 2016; Costa et al. 2016; Natoli et al. 2005; Charlton-Robb et al. 2011; Jedensjö et al. 2017; Gray et al. 2018). The occurrence of *T. aduncus* is limited to the coastal waters of the Indian and Western Pacific Oceans. The holotype is a specimen from the Red Sea and has been confirmed to be the same form of *T. aduncus* that occurs in South Africa and the Western Indian Ocean (Perrin and Brownell 2007). However,

Fig. 5 Indo-Pacific bottlenose dolphin mother and calf, *Tursiops aduncus*, sighted off Dubai, UAE (credit: Ada Natoli/UAE Dolphin Project)

the form occurring in the eastern Indian Ocean appears to be different and is now under taxonomic revision. Indo-Pacific bottlenose dolphin morphology is characterised by a smaller and more slender body compared to its sister species *T. truncatus*, and characteristic ventral spotting is often observed in populations inhabiting the Arabian region (with the possible exception of the Gulf: A. Natoli, pers. obs.). It also has a more coastal distribution than the common bottlenose dolphin, which is typically found in deeper waters.

The Indo-Pacific bottlenose dolphin has been documented throughout the region's coastal waters, and it is one of the more commonly recorded species during small boat surveys. In the Red Sea, its presence in coastal waters has been recorded throughout the basin including the Suez Canal (Notarbartolo di Sciara et al. 2017), and strandings and sightings have been recorded in Yemen, Oman, Iran, United Arab Emirates, Iraq, Kuwait and Pakistan (Braulik et al. 2010a; Gore et al. 2012, 2017; Cowan 2013; Gray et al. 2018; A. Natoli unpublished). There is a dolphin watching industry focused on this species on Qeshm Island, Iran. Indo-Pacific bottlenose dolphins are frequently bycaught in gillnets along the coast of Pakistan and probably elsewhere in the region (Nawaz and Moazzam 2014).

The Indo-Pacific bottlenose dolphin is considered near threatened (Braulik et al. 2019). In the Western Indian Ocean, no dedicated surveys have been conducted to assess the population trend of this species, although bycatch and coastal habitat degradation are observed across its range and likely to negatively influence the local population status. This species is listed in Appendix II of CITES (Fig. 5).

22. **Common Bottlenose Dolphin,** *Tursiops truncatus* (Montagu, 1821)

The common bottlenose dolphin, *T. truncatus*, differs from *T. aduncus* by a larger and more robust body size (frequently exceeding 3 m in length) and a shorter beak delimited from the forehead by a clear crease. Worldwide it occurs from cold temperate to tropical waters showing a wide degree of morphological variability and adaptation to both coastal and pelagic waters. In regions where the Indo-Pacific bottlenose dolphin is present (as in Arabian waters), the common bottlenose dolphin is mostly observed in offshore waters. In the Arabian region, the lack of dedicated offshore surveys and mislabelling of occasional sightings and historical records make an assessment of the presence of this species difficult. To date, its presence is confirmed in the Red Sea (Beadon 1991; Notarbartolo di Sciara et al. 2017), Sea of Oman and Arabian Sea (Baldwin 2003; Minton et al. 2010). Its occurrence is unconfirmed in the Gulf of Aden. Although its presence in the Gulf was mentioned in Mohamed and Hussain (1998), no details were offered by those authors to distinguish the animals they sighted from *T. aduncus*; we suggest that more data be collected before *T. truncatus* is considered present in the Gulf.

Worldwide, this species is listed as least concern by the IUCN Red List (Wells et al. 2019) although where dedicated studies have been conducted, local populations/subspecies have been identified as vulnerable (Mediterranean population: Bearzi et al. 2012), endangered (*Tursiops truncatus ponticus*, Black Sea: Birkun 2012) and critically endangered (Fiordland subpopulation, Currey et al. 2011). The common bottlenose dolphin is listed in Appendix II of CITES.

3.1.6 Odontoceti, Phocoenidae

23. **Indo-Pacific Finless Porpoise,** *Neophocaena phocaenoides* (G. Cuvier, 1829)

The genus *Neophocaena* includes two recently reclassified species (Wang et al. 2008). The Indo-Pacific finless porpoise (*Neophocaena phocaenoides*, Cuvier 1829) occurs throughout the Indo-Pacific northern coastal area from Taiwan and China to its westernmost limit in the Arabian region. The narrow-ridged finless porpoise (*Neophocaena asiaeorientalis*, Pilleri and Gihr 1973–1974) is restricted to the coastal waters of Japan, China, Taiwan and Korea. A subspecies of the latter, *N. a. asiaeorientalis* Pilleri and Gihr 1972, is restricted to freshwater habitats of the middle-lower Yangtze River drainage basin in China.

Throughout its range, the Indo-Pacific finless porpoise favours shallow inshore waters, including mangrove areas, lagoons and estuaries (Pilleri and Gihr 1973–1974; Reeves et al. 1997; Aspinall and Baldwin 1999; Preen 2004; Jefferson and Hung 2004), and this makes it particularly vulnerable to bycatch and anthropogenic impacts (Collins et al. 2005). The Indo-Pacific finless porpoise is recorded in the Gulf throughout coastal waters from the Strait of Hormuz, Iran, Kuwait, Saudi Arabia, Qatar, Bahrain and the UAE (Baldwin 2003; Collins et al. 2005; A. Natoli unpublished). In the Sea of Oman and northern Arabian Sea, its occurrence has been documented by a number of strandings and sightings along the Iranian and Pakistan shores (Baldwin 2003; Collins et al. 2005; Braulik et al. 2010a), but it has never been

Fig. 6 Indo-Pacific finless porpoise, *Neophocaena phocaenoides*, sighted off Dubai, UAE (credit: Ada Natoli/UAE Dolphin Project)

recorded from the Sea of Oman or Arabian Sea shores of Oman. This species has not been recorded in the Red Sea and Gulf of Aden.

According to the IUCN Red List, the Indo-Pacific finless porpoise is considered vulnerable as the population is considered decreasing throughout its range due to the high incidence of accidental bycatch in fishing gears and its preference for coastal waters usually heavily impacted by human activities (Wang and Reeves 2017) (Fig. 6). The species is listed in Appendix II of CITES and Appendix II of CMS.

3.2 Sirenia

3.2.1 Dugongidae

24. **Dugong,** *Dugong dugon* (Müller, 1776)

Dugongs are the only extant Sirenian from the tropical and sub-tropical Indian Ocean, Indo-Pacific and Western Pacific Ocean regions. Despite their wide longitudinal and latitudinal distribution, no subspecies are recognised. However, unlike other more eastern populations, dugongs in the Western Indian Ocean (Red Sea, Gulf, East Africa) have limited genetic diversity (Marsh and Sobtzick 2015).

Dugongs require shallow coastal areas with seagrass beds and water temperatures above a minimum of 15–17 °C (Marsh et al. 2011). In the Arabian Seas region, dugongs are limited to the western part of the Gulf, the Red Sea and limited areas of the Gulf of Aden. The highest numbers are found in the Gulf off the coasts of Saudi

Arabia, Bahrain, Qatar and the UAE (Preen 2004), and they appear to be only occasional visitors to the north Gulf coast. In the Gulf of Aden, dugongs have been reported off Djibouti, but their presence in other parts of the Gulf of Aden is unconfirmed. Portions with seagrass beds could, however, provide suitable habitat (Marsh et al. 2011). Updated information from the Red Sea is limited, but dugongs do occur along the Saudi Arabian coast, with lower densities reported from specific locations in Egypt, Sudan and Eritrea (Preen et al. 1989; Marsh et al. 2011). They are not found along the more exposed coasts of Oman and Pakistan or in the Indus Delta (Roberts 1997). Dugongs are threatened throughout their range by a variety of pressures deriving from human activities, including hunting (legal and poaching), incidental captures in fishing gear, collisions with high-speed vessels, disturbance from tourism activities, and habitat deterioration and destruction, possibly including deterioration caused by climate change (Marsh et al. 2011). All of the above factors are known to occur in the Arabian seas.

The global status of *D. dugon* was assessed as Vulnerable on the IUCN Red List (Marsh and Sobtzick 2015). However, assessments conducted on a regional basis recognised that dugongs from the Red Sea, Gulf of Aden and Gulf should still be considered data deficient (Marsh et al. 2011). Dugongs are listed in CITES Appendix I and in CMS Appendix II. A Memorandum of Understanding on Dugong Conservation was initiated in 2007 under the auspices of CMS; the Arabian Seas region includes eight MoU signatories (Bahrain, Egypt, Eritrea, Saudi Arabia, Somalia, Sudan, United Arab Emirates, Yemen) and nine range states (Djibouti, Iran, Iraq, Israel, Jordan, Kuwait, Oman, Pakistan, Qatar). In addition, the Ramsar Convention on wetlands protects some of the important dugong habitats in the region.

4 Conservation Concerns

On a worldwide basis, marine mammals are subject to a broad array of anthropogenic threats, most recently reviewed by Avila et al. (2018). These include effects of human-produced noise (vessel noise, military sonar, seismic explorations), disturbance from vessel traffic and boat-based tourism, ship strikes, direct takes, bycatch, competitive interactions with fisheries including prey depletion, pollution, coastal development, epizootics, toxic algal blooms and ecological perturbation caused by climate change. Depending on the nature of threats and specific vulnerabilities, deriving impacts can include direct mortality and habitat degradation, ultimately affecting population sizes and/or distribution (Table 2).

The knowledge of the status of marine mammal populations in the Arabian Seas region remains poor because of the low density of the research and monitoring effort there as compared with many other parts of the world. Challenges deriving from the political situation connected with localised unrest, piracy and war significantly add to the difficulties of assessing the current conservation condition of the region's marine mammals. Accordingly, comparing such condition with that of conspecifics from other parts of the world is proving very difficult and sometimes impossible.

Table 2 lists the presence in the region of a several anthropogenic pressure factors which have proven, or are likely, to have an impact on the local marine mammal populations. These include noise produced by seismic exploration, disturbance from poorly regulated or unregulated whale or dolphin watching operations (Fig. 7), disturbance from vessel traffic and connected noise, ship strikes, direct takes, bycatch in fishery operations, pollution, habitat degradation caused by coastal development (Fig. 8) and harmful algal blooms. By contrast, no information is available on the occurrence of other pressure factors known to impact on marine mammals in other parts of the world, such as military sonar-induced mortality, ecological or operational interactions with fisheries other than bycatch (e.g. prey depletion), mortality deriving entanglement in or ingestion of plastics and other man-made solid debris and epizootics (Van Bressem et al. 2014, 2015). Similarly, the possible effects of climate change on marine mammals, already evident in some parts of the world (e.g. Silber et al. 2017), haven't been described in the region's populations as yet.

For instance, nocturnal feeding habits of cetacean species are rarely considered in regional marine impact assessments, particularly for activities associated with offshore oil and gas development (i.e. seismic surveys), many of which also occur at night. We presume a similar lack of attention concerns the implementation of noise-making naval activities. Furthermore, thousands of cetaceans are estimated to be killed as bycatch in extensive regional fisheries for tuna and other pelagic fish and squid species, many of which set large gillnets overnight, and likely also depend on oxygen minimum zone (OMZ) diel patterns (Anderson 2014). The size and depth and persistence of the Arabian Sea OMZ are intimately linked to broader global weather patterns, particularly those of the North Atlantic (Reichart et al. 1998; Lachkar et al. 2018; More et al. 2018). This is of major concern as the effects of climate change are increasingly felt across the globe. The size and scale of oceanic OMZ have increased over recent decades, but the long-term effects of climate change on large oceanic processes, including the maintenance of growth of OMZs, are highly uncertain (Banse et al. 2014; Fu et al. 2018; Lachkar et al. 2018). A recent spate of harmful algal blooms (HABs) and fish kills in the Arabian Seas region may also be linked to climate-driven processes (Harrison et al. 2017).

Considering the poor state of knowledge of the ecology of the region's marine mammals, it cannot be assumed that populations are not affected by the above pressure factors just because of the lack of evidence. In fact, the dearth of information about the ecology of marine mammals from the Arabian region beyond species listings, starting from an understanding of existing population structure and extending to assessments of the conservation status of possible regional subpopulations (with the notable exception of the Arabian Sea subpopulation of humpback whales), still results in our enduring inability to understand where conservation action is most urgent. Particular attention should be given to small cetacean inhabiting the enclosed basins of the region (the Red Sea and the Gulf) to assess their population identity and structure. Research studies conducted in other part of the world (Natoli et al. 2005; Moura et al. 2013; Segura-García et al. 2018) suggest that it is not unlikely that these may represent separate unit to conserve.

Table 2 Threats affecting marine mammals in the Arabian Seas region

Threat	Root cause	Types of possible impact	Metrics to quantify trends	Species likely to be most affected	Supporting evidence from the extended region[a]
Naval sonar	Military activities	Direct mortality	Population size	Cuvier's beaked whale, melon-headed whale	No information available
	Military activities	Short-term habitat degradation causing medium-scale redistribution	Distribution	Sperm whale, Cuvier's beaked whale, melon-headed whale	No information available
Seismic exploration	Oil and gas industry	Short-term habitat degradation causing medium-scale redistribution	Distribution	Bryde's whale, sperm whale, humpback whale, melon-headed whale	Southall et al. (2017), R. Baldwin, pers. obs.
Disturbance from whale/dolphin watching	Unregulated whale/dolphin watching, irresponsible tourism	Short-term habitat degradation causing small-scale redistribution	Distribution	Sperm whale, dugong, Indo-Pacific common dolphin, Indo-Pacific bottlenose dolphin, spinner dolphin, Indian Ocean humpback dolphin	Stensland and Berggren (2007), Notarbartolo di Sciara et al. (2009), Marsh et al. (2011), Ponnampalam (2011), Pérez-Jorge et al. (2016), Gray et al. (2017), Fumagalli et al. (2018), R. Baldwin, pers. obs., H. Moshiri, pers. comm. A. Natoli, pers. obs.
Vessel noise, vessel traffic	Powered vessel traffic	Short-term habitat degradation causing small-scale redistribution	Distribution	Potentially all species	Miksis-Olds et al. (2013), Redfern et al. (2017)
Ship strikes	Powered vessel traffic	Direct mortality	Population size	Bryde's whale, humpback whale, sperm whale, dugong, blue whale	Hanafy et al. (2006), Kershaw et al. (2013), Willson et al. (2016), Gray et al. (2017)

Fisheries	Direct takes	Direct mortality	Population size	Dugong, small odontocetes for shark bait	Preen (2004), Notarbartolo di Sciara et al. (2017)
	Unregulated or inadequately regulated fishery	Direct mortality (through bycatch)	Population size	All species	Preen (2004), Collins et al. (2005), Braulik et al. (2010a, b), Minton et al. (2011), Kershaw et al. (2013), Anderson (2014), Moazzam and Nawaz (2014), Nawaz and Moazzam (2014), Willson et al. (2016), Gore et al. (2017), Gray et al. (2017)
	Various including overfishing and animal behaviour	Direct mortality (from competition with fisheries for shared prey)	Population size		No information available
	Various including poorly managed fishery, possibly combined with climate change	Long-term habitat degradation (depletion of prey) causing medium-scale redistribution	Population size, distribution		No information available
Pollution	Urban and agricultural run-off, oil spills, industrial effluent, navigation accidents	Mortality/health impairment deriving from contact/ingestion of oil and chemical spills, ingestion of noxious substances through food	Population size	Humpback whale, dugong, Indian Ocean humpback dolphin, Indo-Pacific bottlenose dolphin, finless porpoise	Preen (2004), Baldwin et al. (2010), Marsh et al. (2011), Gui et al. (2016), Dakhteh et al. (2017)
	Poor solid waste management, illegal dumping of fishing gear	Direct mortality by entanglement in/ingestion of solid debris	Population size	Potentially all species affected	No information available
Coastal development	Unregulated or inadequately regulated coastal planning	Long-term habitat degradation causing medium-scale redistribution	Population size, distribution	Indian Ocean humpback dolphin, finless porpoise, indo-Pacific bottlenose dolphin, dugong	Collins et al. (2005), Hanafy et al. (2006), A. Natoli pers. comm.

(continued)

Table 2 (continued)

Threat	Root cause	Types of possible impact	Metrics to quantify trends	Species likely to be most affected	Supporting evidence from the extended region[a]
Epizootics	Contagious disease (mostly morbillivirus), possibly enhanced by contaminants	Direct mortality	Population size	Humpback whale (but possibly other species as well)	No information available
Harmful algal blooms	Climate change, pollution	Poisoning from eating prey that have high levels of toxins that were produced by algal blooms	Population size, distribution	Finless porpoise, Indian ocean humpback dolphin, spinner dolphin, indo-pacific bottlenose dolphin	ROPME (1986)
Climate change	Atmospheric carbon loading	Long-term habitat degradation causing large-scale redistribution	Population size, distribution	Indian ocean humpback dolphin, finless porpoise, humpback whale, dugong	No information available

[a]Evidence included from the wider tropical and sub-tropical Indian Ocean. Range of scales referred to in the impact column is as follows: small scale = movements by hundreds of m; medium scale = movements by tens of km; large scale if animals leave the region

Fig. 7 Bathers have opportunities for close interactions with Indian Ocean humpback dolphins, *Sousa plumbea*, off Dubai, UAE (credit: R. Whelan/UAE Dolphin Project)

Fig. 8 Indian Ocean humpback dolphins, *Sousa plumbea*, swimming in an urban landscape off Dubai, UAE (credit: Ada Natoli/UAE Dolphin Project)

Fig. 9 Arabian Sea Humpback Whale Infographic. Courtesy of the Arabian Sea Whale Network

Of special interest is an international initiative dedicated to the conservation of the endemic population of humpback whales, the Arabian Sea Whale Network (ASWN), established in January 2015. The ASWN aims to bring researchers and other stakeholders together to collaborate on a regional level towards conservation of humpback whales in the Arabian Sea. One of the most important elements of this collaboration is the regular exchange of information between members through emails, newsletters and this website. The network also works to ensure that various international bodies are aware of new developments in the region and that they take Arabian Sea whale conservation issues into account in their policies and decision-making processes. Furthermore, the network supports individual members in their local and national research and awareness raising efforts. The main goals of the network are (1) addressing knowledge gaps, (2) information sharing and awareness raising and (3) capacity building, development and implementation of mitigation strategies. ASWN members include representatives of large international NGOs working in the Arabian region, as well as grassroots environmental organisations, regional academic institutions and other whale experts from around the world (Fig. 9).

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